

## **REMARKS**

### **Claim Rejections – 35 U.S.C. § 102/103**

The Examiner has rejected claims 1 and 2 under 35 U.S.C. § 102(e) as being anticipated by Pramanick et al. (US Patent 6,117,770). The Examiner has rejected claims 3-4 and 7 under 35 U.S.C. § 103(a) as being unpatentable over Pramanick et al. (US Patent 6,117,770) in view of Akutsu et al. (US Patent 4,749,584). The Examiner has rejected claims 5 and 6 under 35 U.S.C. § 103(a) as being unpatentable over Pramanick et al. (US Patent 6,117,770).

It is Applicant's understanding that cited references fail to teach or render obvious Applicant's invention as claimed in claims 1-7. In claims 1-7, Applicant teaches and claims a method of forming hardened interconnects for a semiconductor integrated circuit. According to Applicant's claimed method, a metal layer, such as copper, is deposited over a semiconductor wafer surface. Additional metal species are then introduced into the metal layer. After introducing the metal species, chemical mechanical polishing processes performed on the deposited layer. The introduced metal species harden the metal film to thereby more closely match the hardness of the metal film with surrounding oxide layers. This results in better control of the CMP process with less copper dishing and oxide erosion.

It is Applicant's understanding that Pramanick fails to teach introducing additional metal species prior to performing chemical mechanical polishing of the metal film. Pramanick teaches a fill a contact opening 101 formed in a dielectric layer 202 with a barrier layer 122 and a metal film, such as copper. The surface of the metal film is then chemically mechanically polished back to be level with the barrier layer 122 as shown in Figure 2 (Col. 3, line 20-Col. 4, line 4). After chemically mechanically polishing the metal layer (copper) in

channel 101, an alloy material, such as magnesium, boron, tin, zirconium or carbon is introduced into the copper film (Col. 4, lines 5-20). Subsequently, the wafer is heated to cause alloying of the introduced element with the copper film. Thus, Pramanick clearly teaches to polish the copper film before implanting the species 206 into the film. Pramanick fails to teach introducing the species prior to polishing as claimed by Applicant. Thus, Pramanick clearly fails to teach or render obvious Applicant's invention as claimed in claims 1-7.

Additionally, with respect to claim 5, Applicant further claims heating the deposited metal with the introduced metal species prior to chemical mechanical polishing of the metal film. In Pramanick, the metal film (copper) in trench 101 is polished prior to implanting and heating the metal film in trench 101. As such, Pramanick also fails to teach or render obvious claims 5-7 for this reason also.

For the above mentioned reasons, it is Applicant's understanding that Pramanick alone or in combination with Akutsu fails to teach or render obvious Applicant's invention as claimed in claims 1-7. Applicant, therefore, respectfully requests the removal of the 35 U.S.C. § 102 and 103 rejections of claims 1-7 and seeks an early allowance of these claims.

If there are any additional charges, please charge Deposit Account No. 02-2666.

Respectfully submitted,

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**VERSION WITH MARKINGS TO SHOW CHANGES MADE  
IN THE CLAIMS**

1. (Amended) A method for forming hardened [semiconductor] interconnects comprising:

- depositing a metal layer [on] over a semiconductor wafer surface;
- introducing additional metal species into said metal layer; and
- performing chemical-mechanical polishing of said deposited metal layer wherein said additional metal species hardens said deposited metal layer to reduce the rate of said polishing.

5. (Amended) A method for forming hardened [semiconductor] interconnects comprising:

- depositing metal layers [on] over a semiconductor wafer surface;
- introducing additional metal species;
- heating the deposited metal film with the introduced metal species;
- allowing the heated metal film to cool, so as to form precipitates of said introduced metal species; and
- performing chemical-mechanical polishing wherein said additional metal precipitate hardens said deposited metal layer to reduce the rate of said polishing.

Please add new claims 18-21:

18. (New) A method of forming interconnects of an integrated circuit comprising:  
forming an opening in an insulating film formed over a substrate;  
depositing a metal film over said insulating layer and in said opening and filling said  
opening with said metal film;  
introducing an additional metal species into said metal film in said opening and into  
said metal film over said insulating layer; and  
after introducing said additional metal species, chemical mechanical polishing said  
deposited metal film with said additional metal species to remove said metal film from over  
said insulating layer.

19. (New) The method of claim 18 wherein said metal film comprises copper.

20. (New) The method of claim 19 wherein said additional metal species is beryllium.

21. (New) The method of claim 18 further comprising heating said deposited metal film  
with said introduced metal species prior to performing said chemical mechanical polishing.